DOCUMENT RESUME

ED 249 753 EC 170 865

AUTHOR Levine, Shari
TITLE Hemispheric Specialization and Implications for Education of the Hearing Impaired.
PUB DATE [81]
NOTE 18p.
PUB TYPE Information Analyses (070) -- Guides - Non-Classroom Use (055)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cerebral Dominance; *Cognitive Development; *Deafness; Hearing Impairments; *Language Acquisition; *Neurological Organization

ABSTRACT

The paper reviews research on cerebral hemispheric functioning and considers the implications for instruction of the deaf. The nature of right and left hemisphere function and communication is addressed, as are findings on cerebral asymmetry for aspects of language processing. Studies on hemispheric specialization of hearing impaired persons suggest a differential development between deaf and hearing Ss, as opposed to a developmental lag. The development of thought processes in deaf children is traced through the four Piagetian states: sensory motor, pre-operational, concrete operational, and formal operational. Suggestions are offered for facilitating easy passage from one stage to the next, including encouraging the development of an early symbol system for children who are profoundly deaf from birth and using instructional media which utilizes a combined visual and auditory presentation to show relationships, associations, and contrasts. (CL)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED249753

HEMISPHERIC SPECIALIZATION AND IMPLICATIONS FOR EDUCATION OF THE HEARING IMPAIRED

Shari Levine

EC170865

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Shari Levine

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

HEMISPHERIC SPECIALIZATION AND IMPLICATIONS FOR THE EDUCATION OF THE HEARING IMPAIRED

INTRODUCTION

Evidence from several recent studies indicates that the deaf do not develop hemispheric specialization for verbal and nonverbal processing in the same manner as the normal hearing population (Kelly, 1978). These studies suggest that an early severe hearing impairment can influence the lateral organization of the brain for the interpretation of linguistic information. The intent of this paper is to review pertinent research in order to provide a background for understanding the hemispheric findings, and to discuss some of the possible implications for instruction of the deaf.

THE CEREBRAL HEMISPHERES

Clinical and experimental evidence suggests that the human brain is functionally asymmetrical. It appears that the left hemisphere is particularly involved with speech and language and the right hemisphere with nonlinguistic functions (Shedletsky, 1980).

Much of the evidence for citing cognitive functions in the left hemisphere comes from the work of Dr. Roger Sperry of the California Institute of Technology. In performing brain surgery to relieve some of the acute symptoms of epilepsy, and in studying stroke patients, Dr. Sperry and others have collected evidence that is supported by additional experiments with healthy individuals. This research has revealed that cognitive functions--the structuring of language, manipulating of consonant and vowel sounds and word meanings, calculation and other logical operations--are located in

specific areas of the left hemisphere (Claycomb, 1978).

These experiments and observations have also revealed that less structured functions--spatial identification, recognition of vowel sounds, sensory discriminations, recognition of faces, detection of unfamiliar tactile patterns--seem to be more closely associated with the right hemisphere (Claycomb, 1978).

In another example of Sperry's work, right-handed split-brain (a surgical procedure performed on epileptics where the hemispheres are separated in an attempt to limit severe seizures) patients were asked to do writing and drawing tasks. It was discovered that the (right-handed) patients had retained the capacity to write with their right hands, which were controlled by their verbally oriented left cerebral hemispheres. Yet their left hands, controlled by their nonverbal, spatially oriented right hemispheres, could no longer write whole words. Meanwhile, these same individuals were unable to reproduce simple geometric shapes with their right hands, although clearly recognizable reproductions were produced with their awkward left hands (Gray, 1980).

Current research suggests that the hemispheres of normal right-handers have the specialized functions indicated by the data on split-brain right-handers with the added factor that the two hemispheres of a normal brain can mediate through the corpus callosum (a band of fibers that connect the hemispheres). Citing a study by Filbey and Gazzaniga (1977), Ornstein reports that when a verbal or a nonverbal response is required in answer to input into the right hemisphere only, the nonverbal response comes more rapidly than the verbal response, which accounts for time taken to convey the information to the left hemisphere prior to the response. The fact that the verbal response does follow suggests to Ornstein that the brain

hemispheres work together.

Ornstein and his colleague, David Galin, explored the cerebral activity of "normal" right-handed subjects as they performed verbal and spatial tasks. It is their conclusion that their subjects' right hemispheres idled during writing tasks and that their subjects' left hemispheres idled during the spatial block design task. Ornstein and Galin believe that we naturally alternate between our "left" and "right" thinking modes. They suggest that the two modes complement one another without being able to readily substitute for one another (Ornstein, 1977).

RIGHT AND LEFT HEMISPHERE FUNCTION AND COMMUNICATION

The functions of the hemispheres have been further studied by examining patients with aphasia. Damage to the left hemisphere is associated in more right-handed people with a variety of deficits in language expression and comprehension. The left hemisphere plays an important role in symbolic verbal and intentional nonverbal communication--pantomime and gesture. While the right hemisphere controls emotional speech and spontaneous nonverbal behavior--facial and gestural expressiveness (Buck, 1984).

There have also been a number of recent studies implicating the right hemisphere in emotional recognition, both in normal right-handed subjects and brain damaged patients. In normal subjects, it has been found that the left ear (right hemisphere) better recognizes emotional expression in speech in dichotic listening tasks, i.e. how the statement is expressed as opposed to what is expressed. Also there is a left visual field superiority for the processing of faces, particularly faces expressing emotion. In brain damaged patients, it has been found that right hemisphere damaged patients have a particular difficulty comprehending affective speech flow (how it was

said) but not propositional speech (what was said). Therefore, the right hemisphere appears to be particularly well suited for the processing of emotion and spontaneous nonverbal communication, while the left hemisphere plays an important function in interpreting verbal and intentional nonverbal communication (Buck, 1980).

CEREBRAL ASYMMETRY FOR ASPECTS OF LANGUAGE PROCESSING

Some theorists have proposed that the left hemisphere is particularly well suited for analytical processes and the right hemisphere for holistic structural tasks (Shedletsky, 1980). However, how can one account for a complex task, such as sentence comprehension?

Psycholinguistic evidence suggests that sentence processing occurs over time, as the raw incoming signal is transformed into a semantic and syntactic reading (Shedletsky, 1980).

According to Dennis and Whitaker (1976), the left hemisphere performs better at processing the syntactic structures of language, while the right hemisphere demonstrates preference for manipulating the meaning of linguistic stimuli (semantic features).

To review, lateralization can be interpreted as the specialization of certain cerebral mechanisms for a particular function (Kranshen, 1973). Among the peculiarities of the human brain is the fact that language sensory systems are not bilaterally represented to the same extent as are the other true sensory systems (Jerison, 1975). Briefly, the research supports the view that the left hemisphere is responsible for most of the language functions while the right hemisphere is specialized for visual-spatial functions and nonverbal ideations (Kelly, 1977). The lateral processing of the two hemispheres is complementary, particularly for speech and language functions.

HEMISPHERIC SPECIALIZATION OF THE HEARING IMPAIRED

For the normal hearing person, Liberman (1974) has hypothesized that the left hemisphere becomes specialized as the result of processing the grammatical codings involved in speech perception. Do hearing impaired individuals develop a hemispheric lateralization of function similar to hearing people?

Clinical studies of deaf adults who became aphasic and exhibited a communication impairment have been one source of data on the lateralization of language in the hearing impaired. Sarno, Swisher and Sarno (1969) provide evidence that congenitally deaf persons show losses of manual communication skills following left hemisphere lesions. From their findings, Sarno et al. (1969) suggests that aphasia in the deaf is analogous to that of the hearing, with the only difference being in the method of communication that is impaired.

Another source of information on the laterality of the hearing impaired is the psychological research conducted on neurologically normal deaf subjects. McKeever, Hoemann, Florian and Van Deventer (1976) utilized a visual processing task for English words and American Sign Language to examine cerebral laterality in the congenitally deaf. All of their college aged subjects had learned A.S.L. from age five or earlier. Even with this relatively early experience with signing, McKeever et al. (1976) found minimal cerebral asymmetries for processing linguistic and nonlinguistic material. Hence they concluded that auditory experience could be a salient factor in the development of cerebral functional asymmetries. Certainly their data suggests that the cerebral organization of communication functions are not comparable in deaf and hearing individuals. LaBreche, Manning, Gobe and Markman (1977) also found an atypical pattern of hemispheric specialization

in their tachistascopic study of deaf adolescents. They suggest that the congenitally deaf use bilateral representation more than hearing subjects; but they acknowledge some methodological difficulties that might have obscured a left visual field (LVF) dominance for A.S.L. Phippard (1977) compared the hemispheric specialization of deaf subjects (aged 11-19) who used either total communication or oral communication. She found that the deaf subjects whose communication system was exclusively oral showed a LVF advantage for the perception of both verbal and nonverbal stimuli, while no hemifield differences were observed for those whose communication was primarily manual. Her study and the Manning study indicate that a variety of variables probably influence hemispheric specialization.

Scholes and Fischler (1979) devised a task that required adolescents to use both analytical and linguistic processes. Although hearing subjects evidenced the expected right visual field (RVF) superiority, deaf subjects did not. Here again, the loss of audition could have affected hemispheric specialization. Poizner, Battison and Lane (1979) interjected another view after they examined hemispheric specialization for words, static signs from A.S.L., and moving signs. Their findings, that words are processed more efficiently in the left hemisphere, that static signs are processed more efficiently in the right hemisphere, and that moving signs show no functional specialization prompted them to conclude that auditory experience is not a necessary condition for left hemispheric specialization for words.

Although the literature on the cerebral asymmetries of the deaf is sparse, a picture is beginning to emerge. The results discussed above suggest a differential development between the deaf and hearing, as opposed to a developmental lag.

In a study performed by Tomlinson-Keasy and Kelly (1981), designed to examine the effect of auditory input on cerebral lateralization in elementary school children, it was concluded that there are significant differences in the way deaf and hearing individuals respond to a variety of stimuli presented to the two cerebral hemispheres. The hearing children demonstrate significantly greater left hemispheric specialization for words than the deaf. These results suggest that audition may play a role in the development of left hemispheric specialization for words, but it is not critical to the development of some left hemispheric preference.

Another explanation for the results of this study is simply that auditory cues are an easy and abundant source of material for hearing children to analyze and sequence. The lack of this source of information would mean that the deaf must find other stimuli to sequence and analyze. The deaf children favored the right hemisphere and responded significantly quicker than the hearing subjects. These results support the view that an auditory loss has an impact on the developing specialization of the brain.

In an attempt to prove that the deaf are less lateralized than the hearing, Ross, Pergament, and Anisfield (1979) conducted a study involving tachistoscope readings of comparisons between words and signs. Their results suggest that semantic processing is performed by hearing individuals more efficiently in the hemisphere dominant for speech: the left hemisphere. The findings for the hearing impaired group conclude that semantically mediated decisions are processed in the right hemisphere. Also, while the right hemisphere of deaf individuals seems to develop as the specialist for semantic processing, their left hemisphere develops semantic processing capabilities which are equal to those of the left hemisphere

hemispheres are necessary for optimum functioning, it seems that the best environment to stimulate infant brain development is one that activates both sides of the brain. Since very little is currently known about the relationship between different stimuli and hemispheric activation, the message seems to be that infants need exposure to a wide variety of stimulation during the critical first two years of development (Young, 1977).

According to Brooks and Obrzut (1981), environmental cues and the way in which an individual approaches a task can greatly affect hemispheric preference. Therefore, providing stimulation that requires the developing infant to respond by using a variety of processing strategies may help to stimulate both sides of the brain. Such strategies include language related activities (left brain) and visual-spatial activities (right brain). Parents should verbalize in all situations with an infant by describing ongoing activities, events, and objects in the environment. Parents can verbally respond to their infant's needs whether the baby is crying, cooing, or just staring.

In order to stimulate the infant's senses, specific toys can be placed in their environment. Toys for hearing include pendulum clocks, music boxes and wrist bells. (These toys can also benefit a hearing impaired infant who has a hearing aid in good working order.) Toys for seeing include crib mirrors, moving mobiles, ceiling posters, and aquariums. Toys for touching include plastic keys, balls and rings, and plastic disks on metal chains. All of these activities will increase the sensorial experiences for infants and provide stimulation for both sides of the brain (Brooks & Obrzut, 1981).

How are these developing cognitive structures affected by a hearing impairment? How can educators help to compensate for the absence of auditory input?

Piaget traces the development of thought structures through four principle stages, each of which builds on the attainments of the previous ones. These are: (a) the sensory motor period during which the child coordinates sensory experiences and acquires the object concept; (b) the preoperational period during which the child acquires a symbol system; (c) the concrete operational period during which the child begins to make simple transformations of his concrete world and (d) the formal operational period, during which abstract thought processes emerge (Tomlinson-Keasey & Kelly, 1974).

This discussion will begin with the first month after birth, or the sensorimotor period. During this time, the hearing child typically exercises all five sensory pathways. However, since the visual accommodation of a newborn is somewhat limited in terms of function and distance (Haynes, White & Held, 1965), the pathway most often used in processing a distant stimulus is undoubtedly hearing.

During the period from 1-4 months, the child begins to modify all of his sensory abilities. Thus, a hearing child will interrupt or alter his hunger cries when comforted. It becomes clear that the limitations that are imposed on deaf children are already operating (Tomlinson-Keasey & Kelly, 1974). The opportunities for feedback from deaf children and their environment have been lost in one modality. This, no doubt, affects how they organize their sensory motor world. Since they have not exercised the auditory modality,

they have not been aware of the effectiveness of this mode on interaction with the environment.

A major disadvantage of the next phase (the preoperational period) of development occurs with the coordination of sensory pathways. Hearing infants explore the environment by reaching and grasping what they see and turning to look at what they touch or hear. Once the sensory motor structures are coordinated, they are equipped to efficiently and effectively process the information around them (Tomlinson-Keasey & Kelly, 1974).

What happens to the development of deaf children? They are not able to coordinate localizations or auditory input with any of the other senses. Consequently, they rely only on those senses which provide feedback about their interaction with the environment. They develop cognitive structures which do not use auditory input as a central means of processing information. Rather, their structures rely on visual, tactile, gestural, and olfactory cues (Tomlinson-Keasey & Kelly, 1974). Since, at this time (18 months), children begin to develop a symbol system, an image must become attached to a symbol for communication to take place. During this critical language acquisition period, the nature of the intervention is crucial.

According to Conrad (1979), the insistence on an oral language environment for a child who has minimal auditory experience from birth is not beneficial to the child. He contends that early neurological organization may not be adequately developed to process speech. He recommends an early Total Communication Program that emphasizes sign language as early as possible. The results of such training might be a cognitive organization which is well suited for the processing of visual stimuli and one which maximizes the

specialization of cerebral structures for visual input (Conrad, 1979).

Conrad (1979) states that early signing in no way impedes the development of speech later in life. In fact, he contends that the gross movements of simple signing are easier for children to form than the precise articulations of speech, and follow naturally from the gestural behavior common to all infants. Sign language can provide an easily learned mother tongue, which may serve not only a communicative function, but it may preserve and develop the crucial neural organizaiton for language (Conrad, 1979).

When children have learned to affix symbols to mental images, they have progressed through the preoperational stage. The next phase of development focuses on children learning to manipulate the symbols they have acquired. Piaget calls this stage (ages 5-12) concrete operations because children begin to reason or think about their world.

Furth (1971) has determined that when deaf children are tested with nonverbal instruments they perform as well as hearing children at this stage.

Deaf children do, however, have difficulties making the transition from concrete thinking to abstract thinking. This may be due to the absence of auditory input which is most effective for processing distant stimuli. Hence, deaf children do not get much practice in attaching labels to objects they cannot see. Perhaps the loss of the auditory mode eliminates one easy way for the child to practice abstraction, making it difficult for deaf children to pass into Piaget's fourth stage, formal cperations (Tomlinson-Keasey & Kelly, 1974).

IMPLICATIONS FOR EDUCATION

In order to facilitate easy passage from one stage to the next, as well as to encourage the stimulation of both hemispheres during learning, the following suggestions have been proposed:

1) For a child who is profoundly deaf from birth, it would seem advisable to encourage the development of an early symbol system (sign language followed by speech).

2) From preschool on, the cognitive structures should be provided increasingly more complex and divergent visual stimuli to process (Kelly, 1978).

3) Provide ample diversity for auditory processing. Although language stimuli would be ideal, any opportunity to cognitively process a relationship between an obejct and a sound would be beneficial (Kelly, 1978).

4) Provide instructional media which utilizes a combined visual and auditory (perhaps even tactile) presentation to show relationships, associations and contrasts (Kelly, 1978).

5) Use a communication system which allows the exchange of information in a clear and efficient manner and enables the learners to monitor their own performance.

6) Provide a continuity of increasing difficulty. Begin on the child's level and continually encourage them to achieve more (Kelly, 1978).

7) Creativity can be described as the effective integration of both hemispheres of the brain. Most acts of creativity require an individual's right hemisphere to sense something tactily, visually, spatially, or through dreams, mediation, fantasy, or intuition. Such sensations or thoughts can then be transmitted through the corpus callosum to the left hemisphere. Examples of this include:

encouraging the use of art, drama, music (the Orff method) and movement (right brain); graphs, charts, reading, writing, discussions (left brain); and poetry, storytelling, and music writing (left and right brain) (Staley, 1980).

8) Staley (1980) also recommends ample outdoor experiences as a means of learning by doing (right brain) as well as thinking about what is being done (left brain). Education in the outdoors encourages learners to use the outdoors as a living laboratory full of concrete objects and ideas to observe, manipulate, analyze, measure, and record.

9) Teach children to recognize nonverbal expression and emotion by videotaping a group discussion in which members are asked to display moods through tone of voice, body posture and facial expression. Among the impressions conveyed might be tiredness, shyness, illness and sadness. The point of the exercise would be to show the students thay many moods or feelings do not have a single verbal translation (Jensen, 1980).

CONCLUSION

As evidenced by this paper, there appears to be a differential development between the deaf and hearing, as opposed to a developmental lag. In order to promote optimal cognitive and neurological development in hearing impaired students, they must be provided with the opportunity to process a diversity of information. This includes a variety of auditory, visual, and tactile input that stimulates both cerebral hemispheres. With these priorities in mind, appropriate instructional materials can be designed that promote the development of cognitive structures in hearing impaired students.

Ross, P., Pergament, L., & Anisfeld, M. Cerebral lateralization of deaf and hearing individuals for linguistic comparison judgements. Brain and Language, 1979, 8, 69-80.

Sarno, J. E., Swisher, L. P., & Sarno M. T. Aphasia in a congenitally deaf man. Cortex, 1969, 5, 393-414.

Scholes, R. J., & Fishler, I. Hemispheric function and linguistic skill in the deaf. Brain and Language, 1979, 7, 336-350.

Segaloqitz, S. J., & Gruber, F. A. Language Development and neurological theory. New York: Academic Press, 1977.

Shedletsky, L. Cerebral asymmetry for aspects of language processing. Paper presented at the Annual Meeting of the Western Speech Communication Association, Portland, OR, February, 1980.

Staley, F. A. Hemispheric brain research: A breakthrough for outdoor education. Journal of Physical Education & Recreation, 1980, 5, 28-30; 63-64.

Tomlinson-Keasey, C., & Kelly, R. R. The development of thought processes in deaf children. American Annals of the Deaf, 1974, 17, 693-700.

Tomlinson-Keasey, C. & Kelly, R. R. Does listening to language promote hemispheric specialization? Paper presented at the Meeting of the Society for Research in Child Development, Boston, MA, April, 1981.

Whelson, S. F. Left hemisphere specialization for language in the newborn. Brain, 1973, 96, 641-646.

Young, G. Manual specialization in infancy: Implications for lateralization of brain function. In S. J. Segalowitz & F. A. Gruber (Eds.), Language development and neurological theory. New York: Academic Press, 1977.

Jerison, H. J. Evaluation of the brain. UCLA Educator, 1975, 17, 1-8.

Kelly, R. R. Hemispheric laterality of deaf children for processing words and pictures visually presented to the hemifields. American Annals of the Deaf, 1977, 122, 525-533.

Kelly, R. R. Hemispheric specialization of deaf children: Are there any implications for instruction? American Annals of the Deaf, 1978 29, 637-644.

Kinsbourne, M., & Hiscock, M. Does cerebral dominance develop? In S. J. Segalowitz & F. H. Gruber (Eds.), Language development and neurological theory. New York: Academic Press, 1977.

Krashen, S. D. Mental abilities underlying linguistics and non-linguistic functions. Linguistics, 1973, 115, 39-55.

LaBreche, T. M., Manning, A. A., Goble, W., & Markman, R. Hemispheric specialization for linguistic and nonlinguistic tactual perception in a congenitally deaf population. Cortex, 1977, 13, 184-194.

Liberman, A. M. Language processing: State-of-the-art report. In R. E. Stark (Ed.), Sensory capabilities of hearing-impaired children. Baltimore: University Park Press, 1974.

McKeever, W. F., Hoeman, H. W., Florian, V. A., & Van Deventer, A. D. Evidence of minimal cerebral asymmetries in the congenitally deaf. Neuropsychologia, 1976, 14, 413-423.

Ornstein, R. E. The psychology of consciousness. New York: Harcourt Brace Jovanovich, Inc., 1977.

Phippard, D. Hemifield differences in visual perception in deaf and hearing subjects. Neuropsychologia, 1977, 15, 555-561.

Poizner, H., Battison, R., & Lane, H. Cerebral asymmetry for American Sign Language: The effects of moving stimuli. Brain and Language, 1979, 7, 351-362.

References

Brooke, L., & Obrzut, J. E. Brain lateralization: Implications for infant stimulation and development. Young Children, 1981, 36, 9-16.

Buck, R. Left and right hemispheric brain function and symbolic vs. spontaneous communication processes. Paper presented at the Annual Meeting of the Speech Communication Association, N.Y., N.Y., 1980.

Claycomb, M. Brain research and learning. Paper presented at the National Education Association, Wash. D.C., 1978.

Conrad, R. The deaf school child: Language and cognitive function. London: Harper & Row, 1979.

Dennis, M., & Whitaker, H. Language acquisition following hemidecortication: Linguistic superiority of the left over the right hemisphere. Brain and Language, 1976, 3, 404-433.

Furth, H. G. Linguistic deficiency and thinking: Research with deaf subjects 1964-1969. Psychological Bulletin, 1971, 76, 58-72.

Gazzanga, M. S. Cerebral dominance viewed as a decision system. In S. J. Diamond & Y. G. Beaumont (Eds.), Hemisphere function in the brain. New York: Wiley & Sons, 1974.

Gray, E. Brain hemispheres and thinking styles. Clearing House, 1980, 51, 127-132.

Haynes, H., White, B., & Held, R. Visual accommodation in human infants. Science, 1965, 148, 528-530.

Jensen, M. D. Brain specialization research and the teaching of nonverbal communication. Iowa Journal of Speech Communication. 1980, 12, 240-254.